

Description

Electronic Stitch Length Regulator for Home Sewing Machines

BACKGROUND OF INVENTION

[0001] Typically machine quilting is performed by using a sewing machine which uses a mechanical means to control stitch length. Consistent stitch length is accomplished by a set of feed dogs located under the throat plate of the sewing machine that are in contact with the fabric being sewn which, in turn, is in contact with the presser foot of the sewing machine. As the machine runs, the feed dogs alternately grab and release the fabric in precise timing with the up and down motion of the needle. The result is an even stitch based on a mechanical means. However, free motion quilting, as it is called in the art, does not use the sewing machine feed dogs to move the fabric through the sewing machine. In free motion quilting, the quilter controls the rate at which the fabric is moved through the machine independently from the up and down rate of the

needle. The result is uneven stitching. For instance if the needle is moving up and down quickly, but the fabric is moving slowly, the result is a very short stitch length. Conversely, if the needle is moving slowly and the fabric is moving quickly, the result is a very long stitch length. Alternatively, there are quilting frames in the art in which the fabric layers of the quilt are held stationary while the sewing machine, placed on a carriage is moved to create the quilting design. Stitch length is based on the user's ability to regulate the rotational (or stitching) speed of the sewing machine independently of the traveling speed of the sewing machine atop the carriage. This is a difficult if not impossible procedure to master. Thus, there exists a need for an improved method of stitch length regulation for the quilter. Such a means to control stitch length should relate the relative translational speed between the sewing machine and fabric to the rotational speed of the sewing machine to maintain constant stitch length. It is to the provision of such an apparatus that the present invention is primarily directed.

SUMMARY OF INVENTION

[0002] The present invention, in one embodiment thereof, comprises a sensor to measure translational speed of a sewing

machine carriage electrically connected to electronic circuitry which takes the signal generated by the sensor as input and outputs an electrical resistance value in Ohms. This electrical resistance, when applied to the foot pedal control electrical connector of the sewing machine, sets the sewing machine rotational speed. As the sensor detects varying translational speed, the output resistance varies in concert which, in turn, varies the sewing machine rotational speed. In the present embodiment of the invention, the sensor is mounted on the end of a rod, which pivots in a base plate placed on top of a carriage and under the sewing machine. The sensor outputs two signals. The first signal is an alternating voltage with a frequency proportional to the rate of position change, or speed, of the longitudinal axis. The second signal is an alternating voltage with a frequency proportional to the rate of position change, or speed, of the transverse axis. The electronic circuitry of the present invention takes each of the aforementioned signals and converts the respective frequencies to voltages proportional to the frequencies. Furthermore, the voltages from each of the channels are then added together to form a composite voltage proportional to the speed of the carriage. This voltage is then mea-

sured with a multi-step comparator circuit, the output of which controls a multi-step optical-isolator, or opto-isolator, circuit which contains a different resistance value for each step. The output of the circuitry is therefore a resistance that is dependent on the speed of carriage movement. This resistance mimics the resistance of a foot pedal control for the sewing machine. These and other aspects of the present invention will be more apparent from the following description.

BRIEF DESCRIPTION OF DRAWINGS

[0003]

[0004] FIG. 1 is an isometric view of the basic components of a commercially available quilting apparatus containing the addition of an embodiment of the present invention.

[0005] FIG. 2 is an isometric view of a base plate and sensor placement in accordance with embodiments of the present invention.

[0006] FIG. 3 is a block diagram of the methodology by which sensor input is converted to an output resistance which controls sewing machine speed as used in an embodiment of the present invention.

[0007] FIG. 4 is a block diagram of the fundamental stages and

components of the electronic circuitry of the invention.

[0008] FIG. 5 is a block diagram of the final stage of circuitry showing the connection to the sewing machine.

[0009]

DETAILED DESCRIPTION

[0010] FIG. 1 illustrates a quilting frame 1 and its components used for reference in this patent. The frame 1 is described in detail in U.S. Patent No. 6615756. The components of frame 1 of interest in this invention are the longitudinal carriage 2 and the transverse carriage 3 with reference to the coordinate system²⁹. The sewing machine 4 is placed on top of the base plate 5 which is placed on the transverse carriage 3 which is placed on top of the longitudinal carriage 2 which rides on rails 6. The transverse carriage 3 has guide wheels suitably fixed such that only movement in the transverse direction is possible. Similarly, the longitudinal carriage 2 has guide wheels suitably fixed to it such that only longitudinal movement is possible. The sewing machine 4 can move in both the transverse and longitudinal directions using this arrangement. FIG. 2 illustrates the mounting of the position sensor 7 to the sensor arm 8 in one embodiment. The sensor 7 is pivotally

mounted to the sensor arm 8 such that the sensor is free to rotate about an axis parallel to the longitudinal axis. The sensor 7 rests on the table top 13 or other suitable flat surface. The sensor arm 8 is pivotally mounted to the base plate 5 in journals 9 such that the sensor arm 8 is free to rotate in an axis parallel to the longitudinal axis, but is restrained in all other axes. The sensor arm 8 is restrained from sliding in the journals 9 by a preloaded spring 10 and clip 11. Therefore, as the carriage assembly comprised of 2 and 3 is moved in the longitudinal and transverse directions, the sensor 7 moves in the same directions and at the same speed. Also shown is another embodiment where position sensors are shaft encoders 12 attached to the carriage wheels or alternatively independent units suitably attached to the longitudinal and transverse carriages 2 and 3, respectively. The electrical output of the sensor is sent to the electronic control via the sensor wire bundle 14. Two signals are present in the sensor wire bundle 14. The first signal is a voltage with constant amplitude, but frequency varying with longitudinal speed 15 as shown in FIG. 3. The second signal is a voltage with constant amplitude, but frequency varying with transverse speed 16. As shown in FIG. 3, the signals 15 and 16 are

then converted to independent voltages *17* and *18* proportional to their frequencies *15* and *16* respectively. An estimate of the true speed of the carriage comprised of *2* and *3* is obtained by adding voltages *17* and *18* together to form a composite sum voltage *19*. The composite voltage *19* is proportional to carriage speed. The composite voltage *19* is then monitored by a comparator circuit *20* which takes as its input the composite voltage *19*, compares it to established lower *21* and higher *22* bounds, and provides as its output twenty levels of on-off switches or gates. More clearly, as the voltage *19* is increased slightly above the lower bound *21* the first gate or switch allows current to pass through its comparator stage *23*. As the voltage *19* is raised higher, the second gate or switch allows current to pass through its comparator stage *24*. This continues in a similar fashion until the voltage *19* reaches just above the higher bound *22* of the comparator circuit, then the final stage, the twentieth stage *25*, of the comparator circuit is energized allowing current to pass through the final stage *25*. As shown in the block diagram of FIG. 3 and more distinctly in FIG. 4, the gates in the comparator stages control current through one half of an opto-isolator integrated circuit *26*. The function of the opto-

isolator circuit 26 embodied in this invention is to electrically separate the voltages and currents of the control circuitry from the voltages and currents of the sewing machine. As the gates 30 of the comparator circuit 20 cycle on and off in accordance with the speed of the sensor 7, they allow current to pass through light emitting diodes 31, LEDs, embedded within the opto-isolator 26 integrated circuit causing the LED to illuminate. The other half of the opto-isolator circuit 26 is a series of phototransistors 32 which pass electrical current when illuminated by the light of its matching LED. This is integrated with the electronics of the sewing machine as shown in FIG 5. The majority of sewing machines have a foot pedal speed control which is at its core a variable resistor 27. The purpose of this invention is to mimic that variable resistance in a manner such that it varies with the translational speed of the sensor 7 so that the resulting stitch length remains constant. The output of the opto-isolator circuit 26 in conjunction with a plurality of fixed resistors 27 accomplish the task of mimicking the variable resistance. As shown in FIG 5, when the first comparator stage 23 allows current to flow through its gate, illuminating the first stage LED of the opto-isolator, the matching phototransistor is energized

allowing current to flow. The first resistor 28 in the plurality of resistors 27 is thusly electrically connected to the sewing machine. The sewing machine will run at a speed commensurate with the electrical resistance applied to the foot pedal connector. Similarly, as the sensor 7 speed changes in direct response to the change in translational speed of the sewing machine 4, different stages of the comparator circuit 20 will be energized. As a result, different stages of the opto-isolator circuit 26 will be energized causing different phototransistors to be energized which, in turn, cause different resistance values to be applied to the foot pedal connector port of the sewing machine 4. With proper circuit tuning by judicious choice of resistors 27, the rotational speed of the sewing machine can be controlled such that the stitch length is constant, independent of the translational speed, until the point where the translational speed causes the machine to run at its maximum rotational speed. Above that speed, the machine cannot physically rotate any faster and stitch length will elongate.